SCIENCE

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THE ABSENCE OF AIR FROM THE MOON

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ASTRONOMERS have long felt that the absence of air from the moon is a fact that demands some special explanation. Most of the globes in space which are known to us are encompassed by more or less copious atmospheres, why then is the moon an exception? why should there be a gaseous investment to the earth and to Venus, to Mars and to Jupiter, and why should the moon alone be devoid of such covering? The sun and other stars are also so very copiously endowed with gaseous surroundings that the total want of anything of the kind from the moon becomes all the more enigmatical.

At last a light has been thrown on the matter, and an explanation is now provided which is so consonant with the present state of physical knowledge, that I cannot hesitate to accept it. The absence of air from the moon is a necessary consequence of the kinetic theory of gases.

According to the principles of this theory, now generally accepted among physicists, any gas such as oxygen or hydrogen, is composed of molecules which move with an extreme degree of rapidity. The molecules of hydrogen, for instance, which are the most nimble of all the gases in their movements at ordinary temperatures, dash along so fast as to travel on the average somewhat more than 6,000 feet a second. Oxygen and nitrogen have movements which are generally much less than those of hydrogen. But it is to be noted that, in the course of their movements, individual molecules frequently attain velocities very much in excess of the average pace. This is the important point for our present purpose, for on it depends the explanation of the phenomenon of which we are in search.

It can be shown that the mass and the dimensions of the moon are such that if a body were projected upwards from its surface at a pace, let us say, of half a mile a second, that body would ascend to a very considerable elevation, ultimately, however, the attraction of the moon would overcome its outward movement, and the body would tumble back again. If, however, the initial pace were so much greater that it attained a certain critical amount of about a mile a second, then the missile, according to the laws of motion, would ascend from the surface of the moon and go on and on never to be again re-called by any power that the moon's attraction could put forth.

Let us suppose that the moon were now to be invested with a new atmosphere of oxygen or nitrogen. The molecules of these gases will, of course, be darting about with the velocities appropriate to their nature, but, generally speaking, the speeds with which they are animated remain within the limits of velocity which it is in the power of the moon to control. But these are only the average speeds, and it will frequently happen that individual molecules will be animated by a speed equalling or exceeding the critical pace of a mile a second; if this takes place at the upper layers of the moon's atmosphere, the little molecules will take leave of the moon altogether. Other particles follow in the same fashion, and thus it happens that an atmosphere composed of such gases as these we know could not permanently abide on the moon.

On the earth we have and we retain a copious atmosphere. The reason simply is that the earth is massive enough to require that a projectile shall attain a speed of about six miles a second before it goes off and takes leave of our globe. This velocity it would seem that the molecules of oxygen and nitrogen do not generally or ever reach. Hence it is that while the earth can retain the atmosphere with which it was endowed, the moon is unable to do likewise.

SOME ERRORS IN THERMOMETER READINGS.

BY FRANK WALDO, PRINCETON, N. J.

I HAVE understood that the long-awaited comparison of ordinary thermometers with the gas thermometer, at very low temperatures, has been carried out at the International Bureau of Weights and Measures at Sevres. However, I have been unable to get hold of any account of this work, as the official reports concerning it had not been received a short time ago even at the Weather Bureau Library. In Wild's *Repertorium für Meteorologie*, Vol. XV., which has just been received, there is an account of some careful comparisons at low temperatures, which gives results probably not very different from those obtained at Sevres; and a little summary of this will undoubtedly be of interest to some readers. In the St. Petersburg paper,[1] S. Hlasek gives a little summary of the condition of the thermometric standards of the Russian Meteorological Service from the time Director Wild took charge (about 1868) up to the present time. In the present communication, I will not trace through the various thermometer corrections as given by Hlasek, but will merely give the latest results, showing the corrections to be applied to the standard mercurial thermometer at moderate and low temperatures and to the standard spirit thermometer at very low temperatures, to reduce them to the hydrogen gas thermometer, which is the international standard.

Correction of the spirit thermometer by Geissler.		Correction of the standard mercurial thermometer, Geissler No. 10.	
At	Correction.	At	Correction.
− 5° C.	− 0.56° C.	40° C.	− 0.16° C.
− 10	− 0.72	35	− 0.16
− 15	− 0.90	30	− 0.16
− 20	− 1.10	25	− 0.15
− 25	− 1.36	20	− 0 13
− 30	− 1.68	15	− 0.11
− 35	− 1.95	10	− 0 08
− 40	− 2.23	5	− 0.05
− 45	− 2.47	0	0.00
− 50	− 2.72	− 5	+ 0.02
− 55	− 2.95	− 10	+ 0.07
− 60	− 3.15	− 15	+ 0.13
		− 20	+ 0.22
A zero-point correction of + 0.39° C. has been applied in assigning these corrections.		− 25	+ 0.27
		− 30	+ 0.25
		− 35	+ 0.31
		− 40	+ 0.36

These corrections were obtained by means of a normal (Toluène) thermometer, Tonnelot No. 4932, which had been compared with the hydrogen gas thermometer at Sevres.

[1] **Die Temperatur-scalen des Physikal. Cent. Observ. und ihr Verhältness zu der International Temperatur-scale, 1892.**